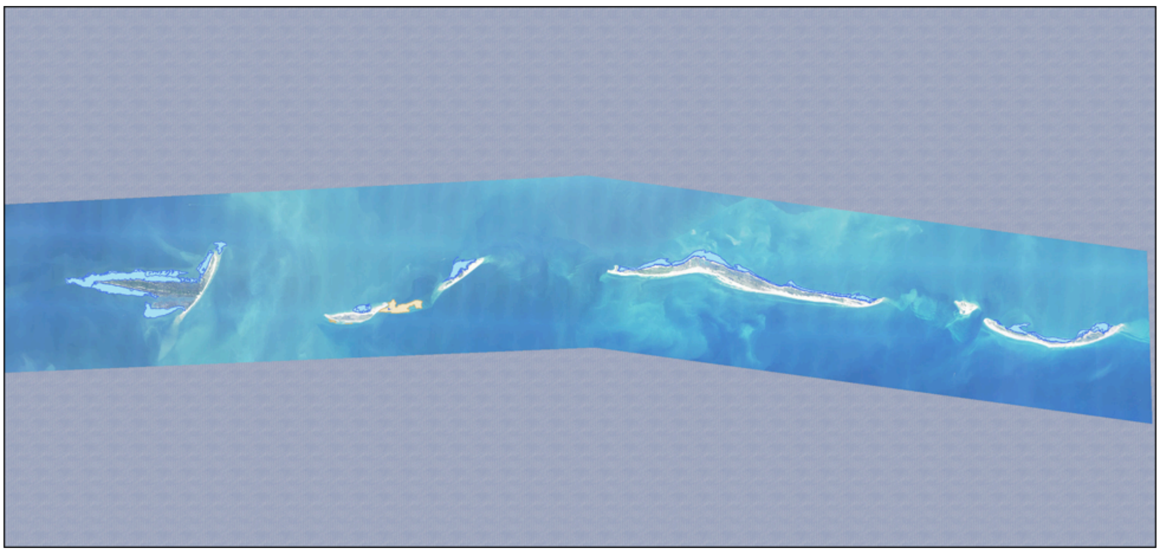
Appendix H
Submerged Aquatic Vegetation Reports

FINAL REPORT

2014 MAPPING OF SUBMERGED AQUATIC VEGETATION

MSCIP BARRIER ISLAND RESTORATION PROJECT



Prepared for

Mobile District Corps of Engineers
P.O. Box 2288
Mobile, AL 36628-0001

Prepared by

Barry A. Vittor & Associates, Inc.
8060 Cottage Hill Road
Mobile, Alabama 36695

March 2015

EXECUTIVE SUMMARY

This is the technical report for the 2014 mapping of submerged aquatic vegetation (SAV) in Mississippi Sound, as part of the Mississippi Barrier Island Restoration project. The geographic focus of this project was the barrier island system off the mainland of coastal Mississippi. This report documents the digital mapping effort that provides detailed information on the distributions of SAV in the barrier island study area.

For this SAV mapping project a digital database was developed using aerial imagery and complementary surface-level verification. Digital orthophotographs were created from native aerial imagery acquired on September 22, 2014 with a digital mapping camera. An Airborne Global Positioning System (ABGPS) and inertial measurement unit (IMU) were used to accurately position each aerial photo center (principal point). Processed ABGPS/IMU data were used in an aerotriangulation procedure to produce a digital elevation model (DEM) surface for imagery rectification. ESRI polygon coverage of SAV was created in ArcView version 9.3. Using ArcView, polygons were drawn to outline the spatial extent of the distribution of SAV signatures observed on the ortho imagery.

Digitized areas were field-verified to document habitat characteristics at the surface level. Field surveys were conducted on October 16 and 17, 2014. Data on species composition, water depth, and other habitat characteristics were collected at a total of 65 field locations. Except for Cat Island, SAV was mostly concentrated on the north side of the islands. SAV was shoal grass (*Halodule wrightii*) at all locations. Shoal grass was mixed with bryozoan colonies and an unidentified macroalga north of East and West Ship Islands. Scattered macroalgal patches occurred on the West Ship south side near its western tip, and at the West Ship eastern tip, extending across an area of the sand shoal within Camille Cut. The macroalga was not present in these areas in 2010.

Overall, a total of 3,822 acres of SAV was mapped, compared to 3,614 ac in 2010. Bed densities were mostly patchy (< 50% coverage). The largest difference between the two surveys was at Cat Island, which in 2014 had polygons comprising 338 acres more area compared to the 2010 survey. There was slightly more acreage at Horn Island in 2014 compared to 2010. Acreage at East and West Ship Islands and Petit Bois Island was less in 2014 compared to 2010. There were some minor distributional differences in SAV occurrence between the two surveys.

Location	Density	2014 Acreage	2010 Acreage
Cat Island	Continuous	459	178
Cat Island	Patchy	1,591	1,534
West Ship Island	Patchy	76	125
East Ship Island	Patchy	242	261
Horn Island	Patchy	997	974
Petit Bois Island	Patchy	457	541

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

This is the technical report for the 2014 mapping of submerged aquatic vegetation (SAV), as part of the Mississippi Barrier Island Restoration project. The geographic focus of this project was the barrier island system off the mainland of coastal Mississippi (Figure 1). This mapping project is an update to the 2010 SAV survey of the MsCIP barrier island project area.

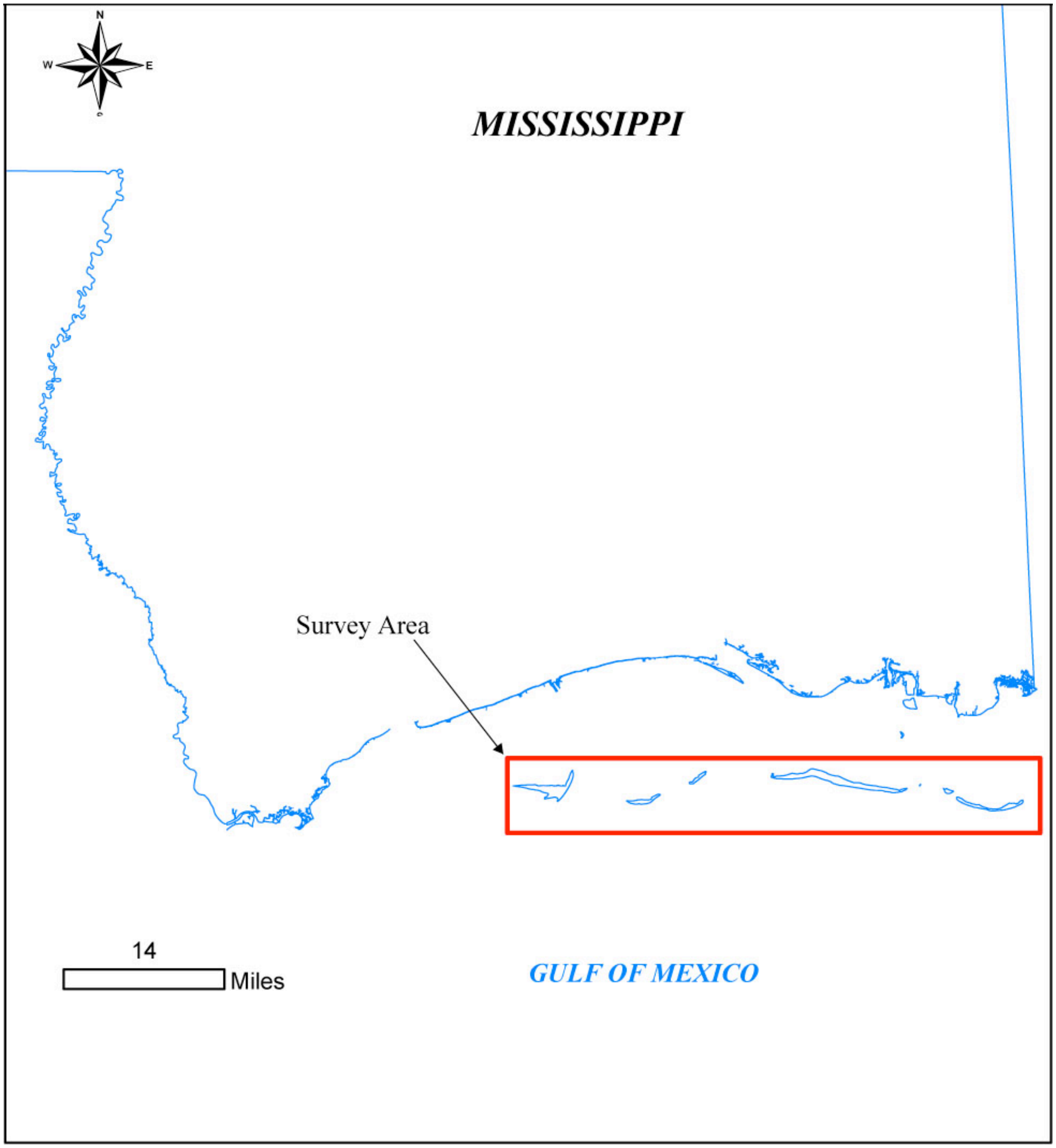


Figure 1. Study area for the MSCIP 2014 SAV survey.

For this SAV mapping project a digital database was developed using aerial imagery and complementary surface-level verification. This project was conducted within the technical framework of benthic feature mapping methods established by the *NOAA Coastal Change Analysis Program* (C-CAP) (Dobson et al., 1995). The C-CAP is a nationally standardized database of land cover and land change information in coastal areas, developed using remotely sensed imagery. The C-CAP outlines methods and provides technical guidance for digital feature mapping.

2.0 METHODS

2.1 ORTHOPHOTOGRAPHY PRODUCTION

Photo Science of St Petersburg, FL acquired the aerial imagery and produced the ortho imagery for this mapping project. The orthorectification process relied on digital aerial imagery, ground control/aerotriangulation data, and a digital elevation model (DEM). The aerial mapping technology used was airborne Global Positioning System (ABGPS) and an inertial measurement unit (IMU) to accurately position each aerial photo center (principal point).

Aerial imagery was acquired September 22, 2014, using a Z/I Imaging Digital Mapping Camera (DMC). The DMC was equipped with eight (8) cameras heads, four (4) for panchromatic and one (1) each for red, blue, green and NIR (near-infrared). During imagery acquisition the aircraft flew at 27,000 feet AMT to render a native pixel resolution of 1 meter for the entire study area. A total of 171 individual frames were acquired at and formatted for 60% endlap and 30% sidelap.

A computerized flight-management system consisted of ABGPS-supported aircraft navigation, interfaced with flight control software. After initial flight planning, digitized mission data was fed into the flight-management system. The start and stop points of each flight line were processed by the aircraft's onboard navigation system. An Applanix IMU ensured that tip, tilt, and swing of the camera for each frame was less than 3 degrees. Resolution loss due to blurring was avoided by a forward image motion compensation (FMC) system. Image motion did not exceed 0.002 inches. The Applanix POS/AV-DG IMU system measured the position of the camera perspective center and orientation angles of each photograph at the midpoint of exposure, to an accuracy of 5-10 cm and 20-30 arc seconds, respectively. The GPS receiver precisely captured the midpoint of each photo exposure.

Dual-frequency GPS observation data were collected on-board the aircraft at a one second epoch. Additionally, inertial data were collected at a rate of 0.005 seconds during the flight. ABGPS and inertial data was post-processed using Applanix MMS version 5.2 software, to provide accurate positional and rotation data of the camera. Effectively, the three dimensional position (x, y, and z) of each exposure was determined from the ABGPS data while the three-dimensional rotation (omega, phi, and kappa) of each exposure was determined from the inertial data.

ABGPS coordinates were automatically collected for the principal point for each photographic frame. The ABGPS/IMU recorded the position and orientation of the camera platform. Exact measurements obtained from the ABGPS and IMU provided positional accuracy of the resultant imagery. The processed GPS/ABGPS/IMU data were used in an aerotriangulation procedure for imagery rectification.

Color balancing was performed on the raw images prior to rectification, to provide a consistent tone, brightness and contrast throughout the project area. A USGS 30-m DEM was used for the orthorectification process. The DEM removed inherent imagery displacements, such as distortions resulting from camera tilt and ground relief, to create orthophotographs with uniform scale and accuracy. The rectification methodology sharpened the edges of linear features and sampled 16 of the closest pixels to perform a weighted adjustment. Orthophotos were produced as individual rectified image frames. In addition, a low-resolution mosaic was created in a MrSID format. These products are projected to North American Datum of 1983, Universal Transverse Mercator (UTM) Zone Number 16 North, and meters.

2.2 SAV DATA DEVELOPMENT

Field Surveys

The aerial imagery was reviewed prior to field surveys to develop initial assumptions of SAV location and habitat classification. In addition, the results of the MsCIP 2010 SAV survey were reviewed. Locations of interest were pre-plotted in GPS to aid navigation in the field. In addition to areas appearing to contain SAV, locations with questionable or ambiguous signatures in the aerial imagery were identified and pre-plotted for field verification, to help validate the spatial and thematic accuracy of the delineation.

Field surveys were conducted on October 16, 2014 at Horn Island and Petit Bois Island, and on October 17 at Cat Island, West Ship Island and East Ship Island. There were westerly winds, moderate waves, and moderately turbid conditions on October 16, whereas the following day had minimal wind and waves and good water clarity.

Field surveys documented SAV presence or absence, bed patchiness, water depth, and other habitat characteristics. At each field location with SAV the immediate area was visually assessed as continuous (>50%) or patchy (<50%), and was sampled using a 5-ft steel garden rake to collect SAV or other benthic material. Depth (ft) was measured with a graded sounding pole.

Each field location was logged using a Trimble Pro XR differential GPS unit, following common GPS practices. An elevation mask of 6 was used to avoid degraded signals from satellites. A Positional Dilution of Precision (PDOP) threshold of 6, data logging at 2-second intervals, and real-time differential correction/post-processing of the field data collected horizontal positional data accurate to within 1 meter. Data were collected at a total of 65 field locations (Appendix A).

Creation of Polygonal and GIS Database

ESRI polygon coverage of SAV was created in ArcView version 9.3. Using ArcView, polygons were drawn to outline the spatial extent of the distribution of SAV signatures observed on the ortho imagery. The initial estimation of SAV locations and polygonal development was performed in ArcGIS at an approximate scale of 1:6000 (1" = 500'). Subsequent refinement at finer scales was focused on the inner and seaward limits of SAV occurrence, and other areas of interest. Polygons were visually assessed for vegetation density on-screen and categorized as continuous (>50%) or patchy (<50%) coverage. Once the preliminary polygonal line work was complete, vector coverage was created through editing and labeling the line work, and incorporating the field data.

Metadata Production

Metadata was created by default using ArcGIS Desktop 9.3. The Metadata was generated according to the Federal Geographic Data Committee's (FGDC) *Content Standard for Digital Spatial Metadata* (CSDGM), in an HTML format.

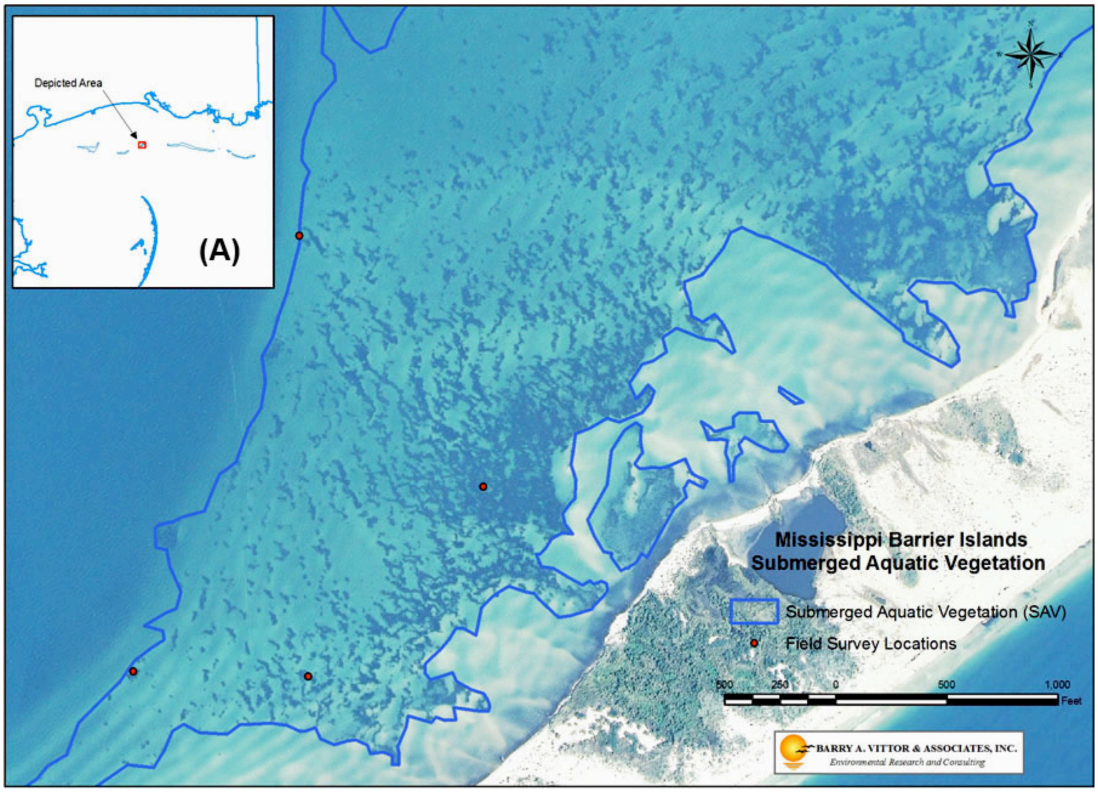
QA/QC

In accordance with the approved QA/QC Plan, the raw digital imagery was inspected prior to orthorectification to ensure a condition suitable for benthic feature mapping, and to pre-plot field points for inspection. Two analysts identified SAV signatures using a screen display with the ortho imagery as a base map. The analysts visually reviewed the polygons superimposed on the digital imagery to check completeness and edges, and consulted regarding questionable areas. The entire polygonal data set was reviewed after completion. The polygon labels were reviewed for proper incorporation of field data and overall thematic accuracy.

3.0 RESULTS AND DISCUSSION

Table A-1 (Appendix A) presents the field data. The field surveys found that initial assumptions of habitat type based on the aerial imagery were mostly validated for vegetated versus non-vegetated bottoms. The spatial locations of the inner and seaward SAV bed boundaries were also consistent with the aerial imagery signatures. SAV was shoal grass (*Halodule wrightii*) at all sampled locations. The shoal grass occurred at depths ranging from 2.8 to 6.2 ft, with an average depth of 4.2 ft for the entire study area.

Shoreline signatures at all of the islands in both 2014 and 2010 comprised senesced and uprooted shoal grass and other detritus. A questionable signature along the eastern shoreline of Cat Island was also found to be detrital material. Readily visible signatures on the south side of West Ship Island and the area between West and East Ship were found to be macroalgal clumps embedded in the sediment. Several GPS points were logged in these areas, and separate polygons were created to distinguish the algal clumps from shoal grass areas.



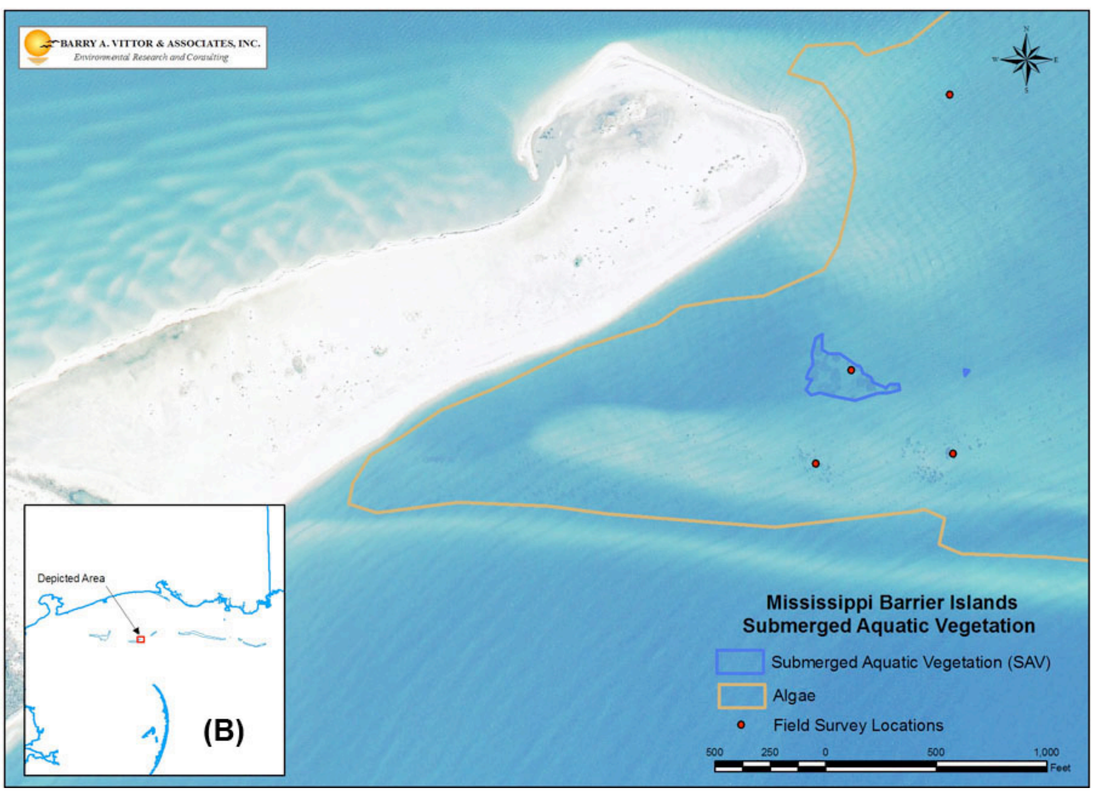


Figure 2. 2014 aerial imagery showing (A) shoal grass on the northern side of East Ship Island and (B) near West Ship Island's eastern end in an area of scattered macroalga patches.

SAV was mostly concentrated on the north side of the barrier islands (Figure B-1; Appendix B). Figures B-2 through B-5 show the distribution of SAV at each island. Maps presenting a comparison of the 2014 and 2010 surveys are presented in Appendix C.

At Cat Island in 2014 (Figure C-1), there was more expansive coverage of patchy shoal grass on the north-trending spit of the island's eastern edge, and to the west of the south-trending tip, compared to 2010. The inner margins of the beds on the north side of the island were nearer the shoreline in 2014 compared to 2010. Also, on the south side of the island there was greater spatial coverage of continuous shoal grass in 2014 compared to 2010.

An area of patchy shoal grass on the north side of West Ship Island was less extensive in 2014 compared to 2010 (Figure C-2), and in 2014 was mixed with a macroalga and bryozoan colonies that were not observed in the 2010 survey. Behind East Ship Island, the 2014 area of patchy shoal grass was largely unchanged in distribution compared to 2010, with slight expansion to the east and some regression away from the shoreline. As was the case at West Ship, shoal grass at East Ship was mixed with the macroalga and bryozoan colonies.

Monotypic macroalgal patches occurred on the West Ship south side near its western tip. These scattered patches also occurred at the West Ship eastern tip, extending across an area of the sand shoal within Camille Cut. The macroalga was not present in these areas in 2010. A relatively small area of shoal grass occurred within a 344-acre area of scattered macroalgal patches east of the island (Figure 2b).

Eleuterius (1973) mapped SAV and macroalgae distributions based on 1969 field surveys using north-south transects. In that investigation, most of the study area had algae mixed with SAV, primarily unidentified red and brown algae and shoal grass. At that time there was a large area of algae surrounding Cat Island, extending about 2 miles westward of the island, near the limits of present-day shoal grass occurrence. At Dog Keys, the shallows between Ship Island and Horn Island, an expansive area with mixed algae and patchy shoal grass was present (Eleuterius, 1973). The 1992 mapping performed by Moncreiff et al. (1998) was specific to SAV and potential SAV habitat, and did not address the presence or absence of algae.

Eleuterius (1973) did not identify the algae he mapped, referring only to red, brown and green species. The macroalga observed in 2014 occurred in a red form in the monotypic clumps south and east of West Ship Island. It appeared that this same alga was mixed with shoal grass and bryozoans behind West and East Ship Islands in a green form, and the alga is similar to species identified as belonging to the genus *Gracilaria*.

Horn Island and Petit Bois Island in 2014 were largely similar to 2010 in the acreage and distribution of patchy shoal grass. At Petit Bois in 2014, there was some receding of the inner shoal grass boundary away from the shoreline, and some expansion of patchy SAV on a shoal near the west end of the island.

Polygon acreage mapped in 2014 is presented in the following table, along with acreages mapped in 2010:

Location	Density	2014 Acreage	2010 Acreage
Cat Island	Continuous	459	178
Cat Island	Patchy	1,591	1,534
West Ship Island	Patchy	76	125
East Ship Island	Patchy	242	261
Horn Island	Patchy	997	974
Petit Bois Island	Patchy	457	541

Overall, a total of 3,822 acres of bottom area was mapped in 2014, compared to 3,614 acres in 2010. The largest difference between the two surveys was at Cat Island, which had an additional 338 acres in 2014 compared to 2010. The distribution of SAV in 2014 was similar to the 2010 survey and to prior studies in the project area (Eleuterius, 1973; Moncreiff et al., 1998). While there were some changes in the spatial extent of the bed boundaries, the general distribution of SAV in the study area appears to be broadly stable.

4.0 REFERENCES CITED

Dobson, J.E., E.A. Bright, R.L. Ferguson, D.W. Field, L.L. Wood, K.D. Haddad, J.R. Jensen, H. Iredale, V.V. Klemas, R.J. Orth, and J.P. Thomas, 1995. NOAA Coastal Change Analysis Program (C-CAP): Guidance for Regional Implementation. NOAA Technical Report NMFS 123. U.S Department of Commerce.

Eleuterius, L.N., 1973. Phase II: The distribution of certain submerged plants in Mississippi Sound and adjacent waters. Pp. 191-197, In J.Y. Christmas (ed.), Cooperative Gulf of Mexico Inventory and Study, Mississippi. Gulf Coast Research Laboratory, Ocean Springs, MS.

Moncreiff, C.A., T.A. Randall, and J.D. Caldwell, 1998. Mapping of Seagrass Resources in Mississippi Sound. Gulf Coast Research Laboratory, University of Southern Mississippi, Ocean Springs, MS. 41 pp.

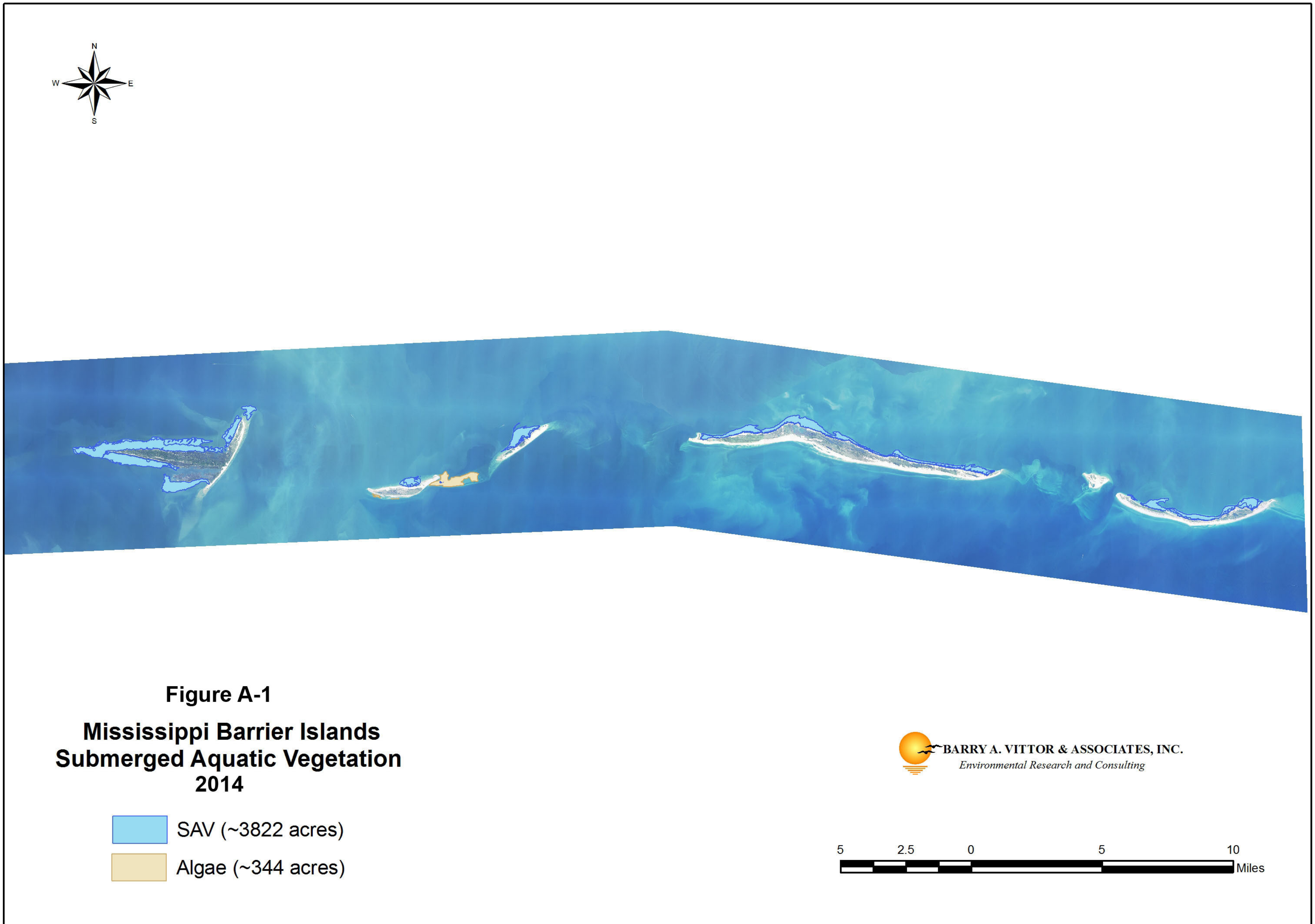
APPENDIX A – FIELD POINT DATA

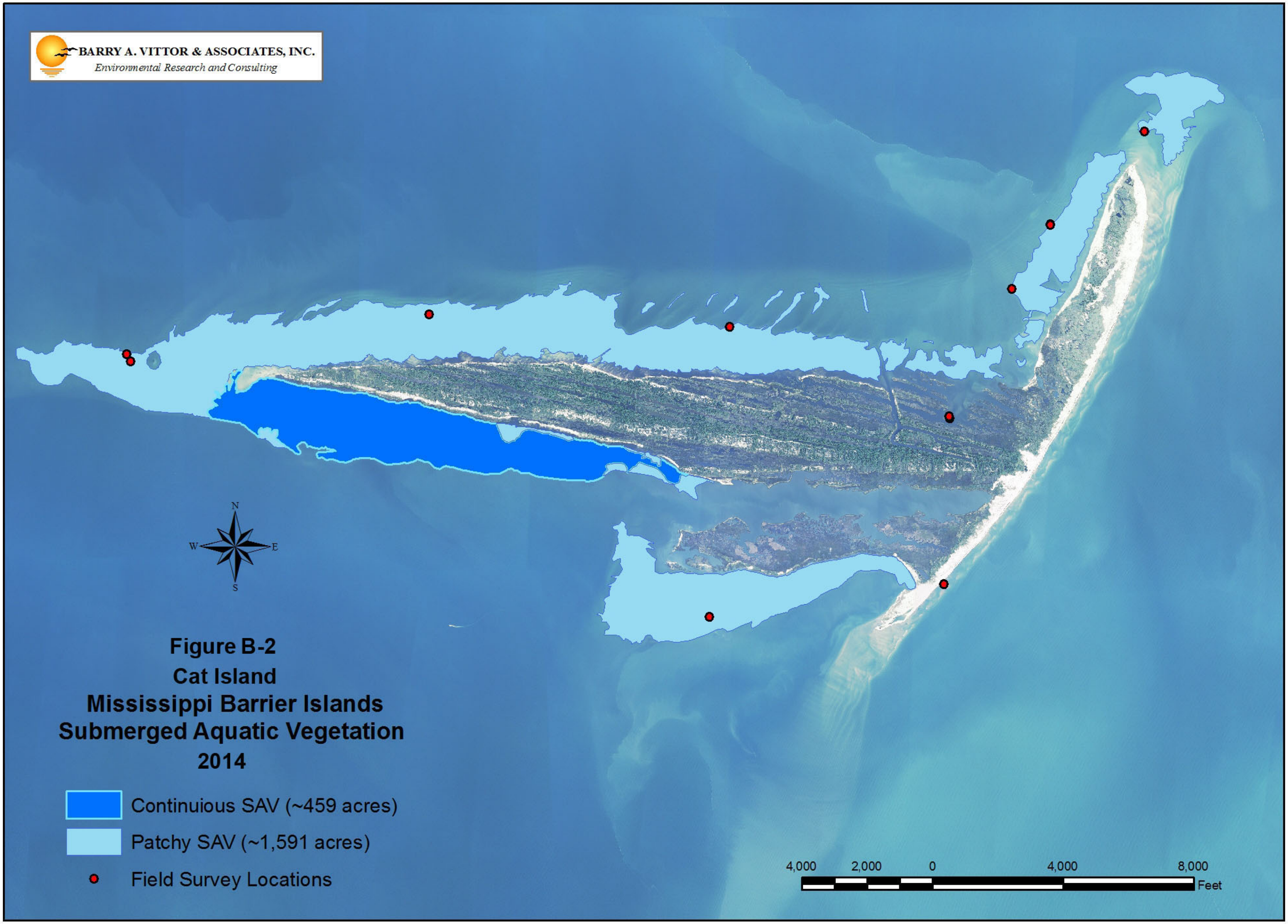
TABLE A-1. 2014 SAV Survey Field Points

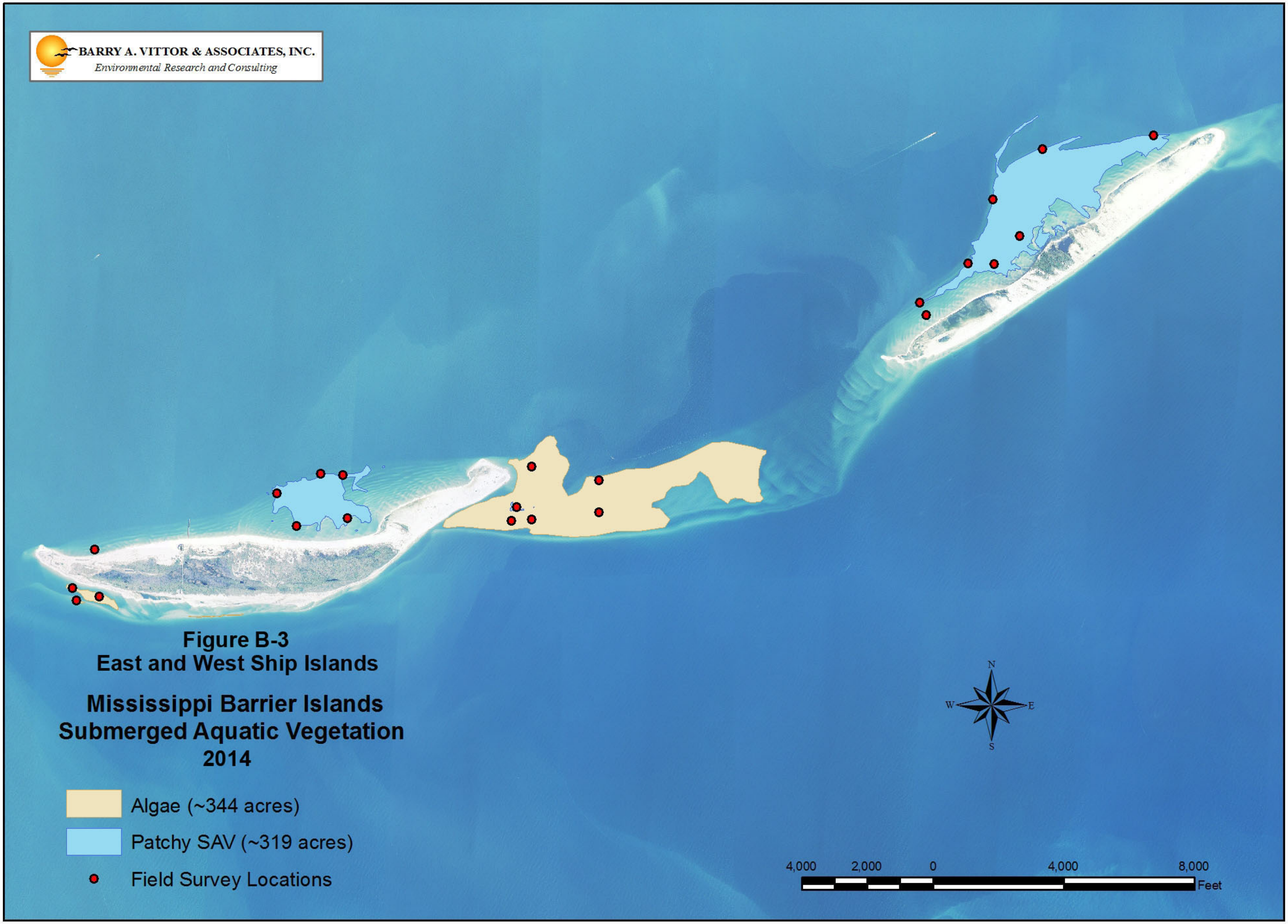
Species	Water Depth (ft)	comment	x	y
no SAV	2.8		363877.70	3343054.97
no SAV	5.6		363552.40	3343255.84
Halodule wrightii	2.8	patchy	363230.04	3342689.22
Halodule wrightii	4.0	patchy	363076.29	3342926.07
Halodule wrightii	4.1	patchy	362902.48	3343092.37
Halodule wrightii	5.3	patchy	362808.20	3343132.96
Halodule wrightii	5.1	patchy	361890.40	3342833.15
Halodule wrightii	4.5	patchy	360721.69	3342148.16
Halodule wrightii	4.6	patchy	359728.86	3342289.13
Halodule wrightii	4.6	patchy	359230.62	3342336.30
Halodule wrightii	3.8	patchy	357878.06	3342708.60
Halodule wrightii	4.6	patchy	357063.37	3343049.43
Halodule wrightii	4.4	patchy	356832.65	3343127.35
Halodule wrightii	4.4	patchy	356506.26	3343024.31
Halodule wrightii	3.7	patchy	347342.92	3345026.60
Halodule wrightii	4.9	patchy	346588.97	3345202.53
Halodule wrightii	3.4	patchy	346115.40	3345217.52
Halodule wrightii	3.1	patchy	345294.66	3345354.43
Halodule wrightii	4.6	patchy	344246.06	3345426.92
Halodule wrightii	4.4	patchy	342637.47	3345670.73
Halodule wrightii	3.8	patchy	339752.44	3346303.86
Halodule wrightii	4.9	patchy	337045.21	3347376.44
Halodule wrightii	3.6	patchy	336657.41	3347619.19
Halodule wrightii	2.9	patchy	301218.39	3348486.08
Halodule wrightii	3.5	patchy	300343.88	3347622.09
Halodule wrightii	3.1	patchy	299982.44	3347018.58
Halodule wrightii	4.1	patchy	297346.93	3346665.23
Halodule wrightii	3.1	patchy	294544.61	3346780.66
Halodule wrightii	4.5	patchy	291758.20	3346341.87
Halodule wrightii	3.9	patchy	297163.44	3343960.89
Halodule wrightii	5.2	patchy	311065.12	3344464.80
Halodule wrightii	6.2	patchy	311475.22	3344651.82
Halodule wrightii	3.5	patchy	311722.46	3344234.75
Halodule wrightii	5.2	patchy	313304.61	3344337.62
Halodule wrightii	3.1	patchy	317063.44	3346248.02
Halodule wrightii	4.4	mixed w/ algae, bryozoa	317516.33	3346613.97
Halodule wrightii	3.1	mixed w/ algae, bryozoa	317756.51	3346606.54
Halodule wrightii	4.1	mixed w/ algae, bryozoa	317996.44	3346866.50
Halodule wrightii	3.8	mixed w/ algae, bryozoa	319246.18	3347807.68
no SAV	3.1		361062.02	3342089.88

no SAV	6.6		356471.89	3343069.30
no SAV	3.6		355948.06	3343242.92
no SAV	3.2	concrete	355758.56	3343384.67
no SAV	2.4	floating SAV @ shore	347774.76	3345088.59
Halodule wrightii	3.5	patchy	300341.07	3347614.25
no SAV	3.1		299403.57	3345814.70
no SAV	2.1		299394.92	3345829.42
no SAV	4.9		291723.31	3346412.02
no SAV	5.3	algae	309157.75	3343579.76
no SAV	2.7		309364.06	3343942.86
no SAV	4.1	algae	313440.31	3344717.30
no SAV	3.5	algae	313256.25	3344208.62
no SAV	3.5	algae	313444.73	3344222.20
no SAV	4.3	algae	314073.85	3344287.93
no SAV	4.9	algae	314069.03	3344588.18
no SAV	3.0	algae	317125.13	3346130.12
no SAV	5.4	algae	309408.38	3343501.35
no SAV	6.8		309195.99	3343464.98
Halodule wrightii	4.2	patchy	336025.95	3348200.93
Halodule wrightii	5.1	Patchy	331523.95	3347602.06
no SAV	1.9	Hole/debris	299347.63	3344263.10
Halodule wrightii	5.4	patchy	311683.50	3344634.01
Halodule wrightii	3.2	patchy	311247.71	3344164.05
Halodule wrightii	5.3	patchy	317744.19	3347209.94
Halodule wrightii	4.8	patchy	318210.22	3347678.44
X & Y Coordinates are UTM, NAD 1983, 16N, Meters				

APPENDIX B – 2014 SAV DISTRIBUTION MAPS


N
W
E
S
Figure A-1
Mississippi Barrier Islands
Submerged Aquatic Vegetation
2014
SAV (~3822 acres)
Algae (~344 acres)
BARRY A. VITTOR & ASSOCIATES, INC.
Environmental Research and Consulting
5
2.5
0
5
10
Miles


BARRY A. VITTOR & ASSOCIATES, INC.
Environmental Research and Consulting
N
W
E
S
Figure B-2
Cat Island
Mississippi Barrier Islands
Submerged Aquatic Vegetation
2014
Continiuious SAV (~459 acres)
Patchy SAV (~1,591 acres)
Field Survey Locations
4,000
2,000
0
4,000
8,000
Feet



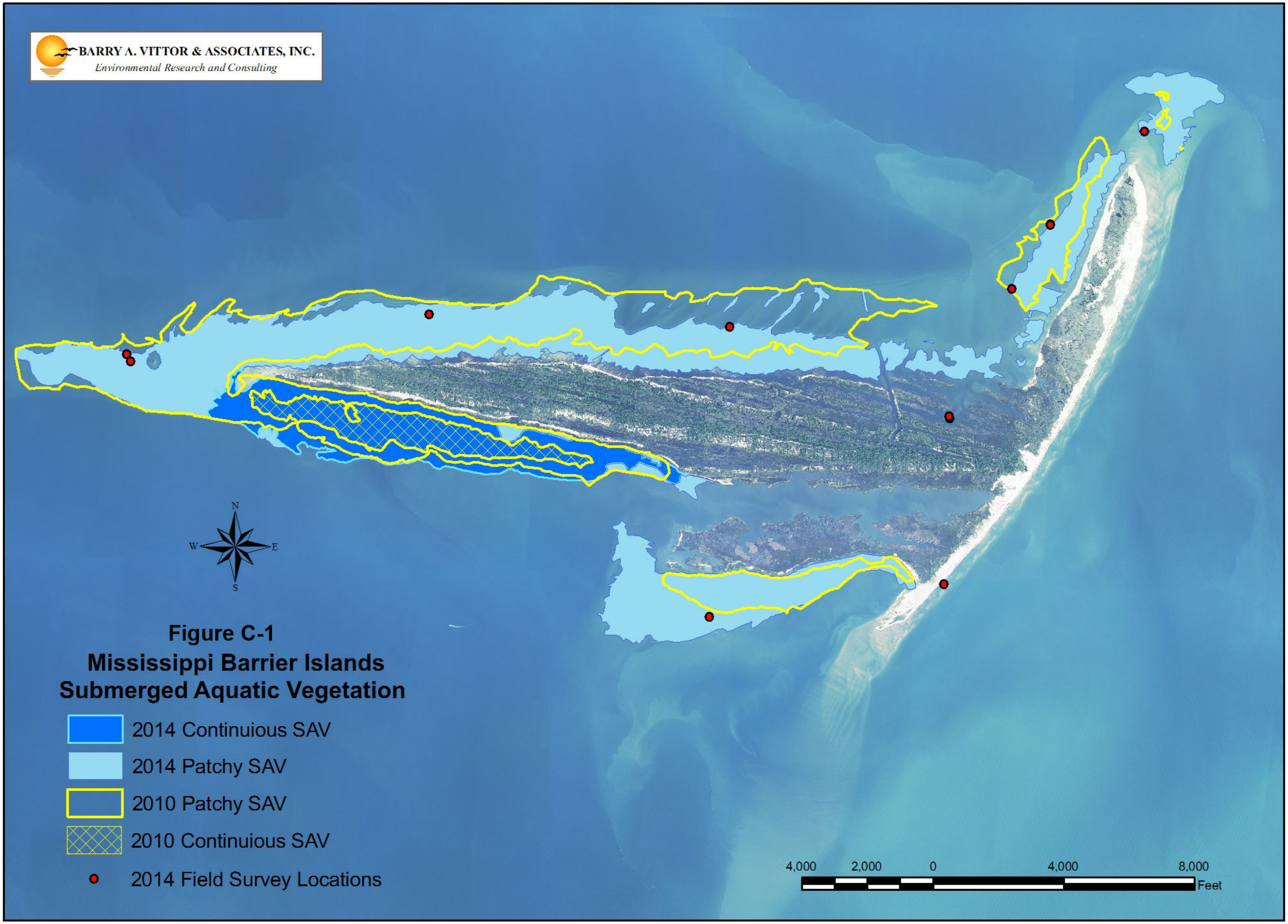
BARRY A. VITTOR & ASSOCIATES, INC.
Environmental Research and Consulting
Figure B-3
East and West Ship Islands
Mississippi Barrier Islands
Submerged Aquatic Vegetation
2014
Algae (~344 acres)
Patchy SAV (~319 acres)
Field Survey Locations
N
W
E
S
4,000
2,000
0
4,000
8,000
Feet

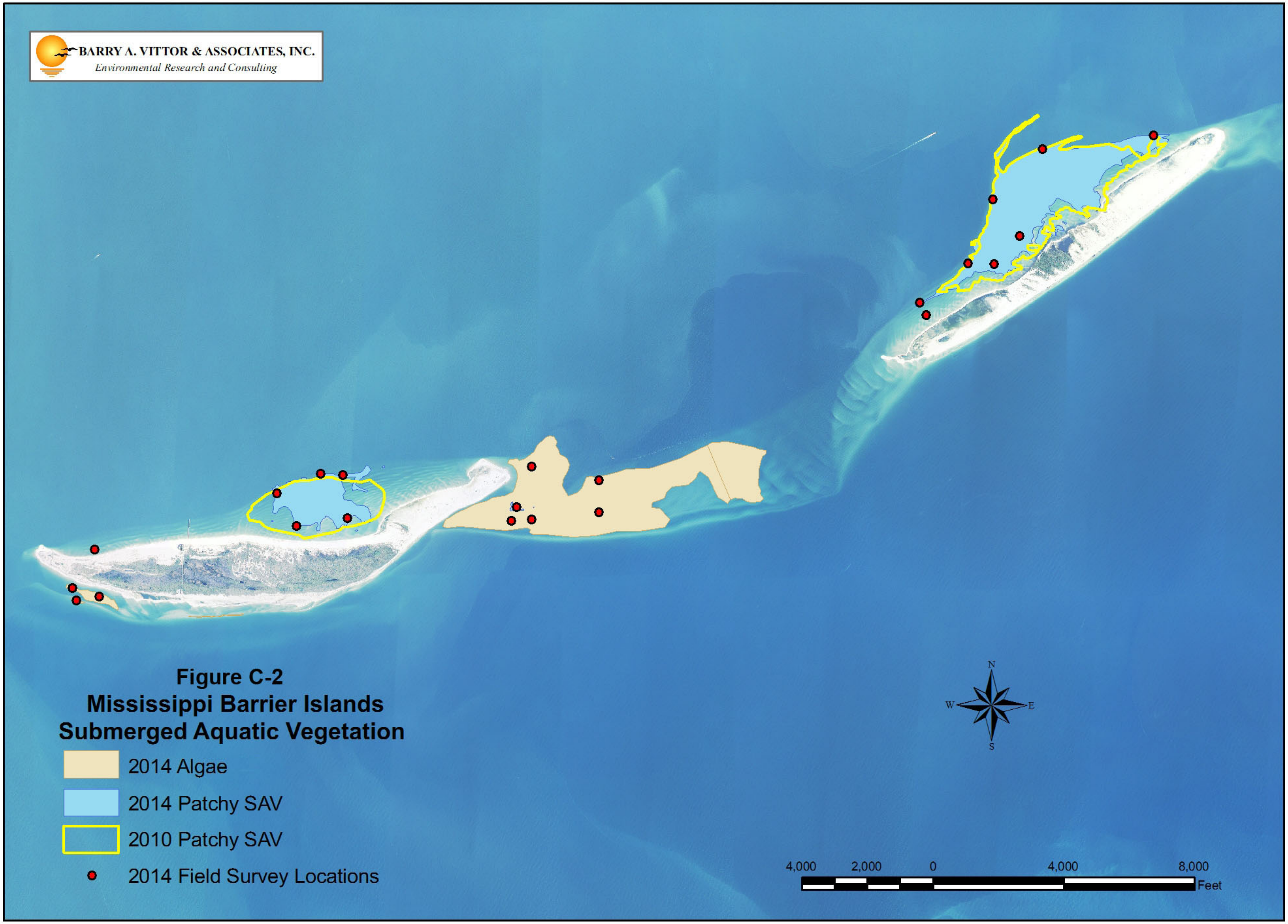
BARRY A. VITTOR & ASSOCIATES, INC.
Environmental Research and Consulting
Figure B-4
Horn Island
Mississippi Barrier Islands
Submerged Aquatic Vegetation
2014
Patchy SAV (~997 acres)
Field Survey Locations
N
W
E
S
7,000
3,500
0
7,000
14,000
Feet

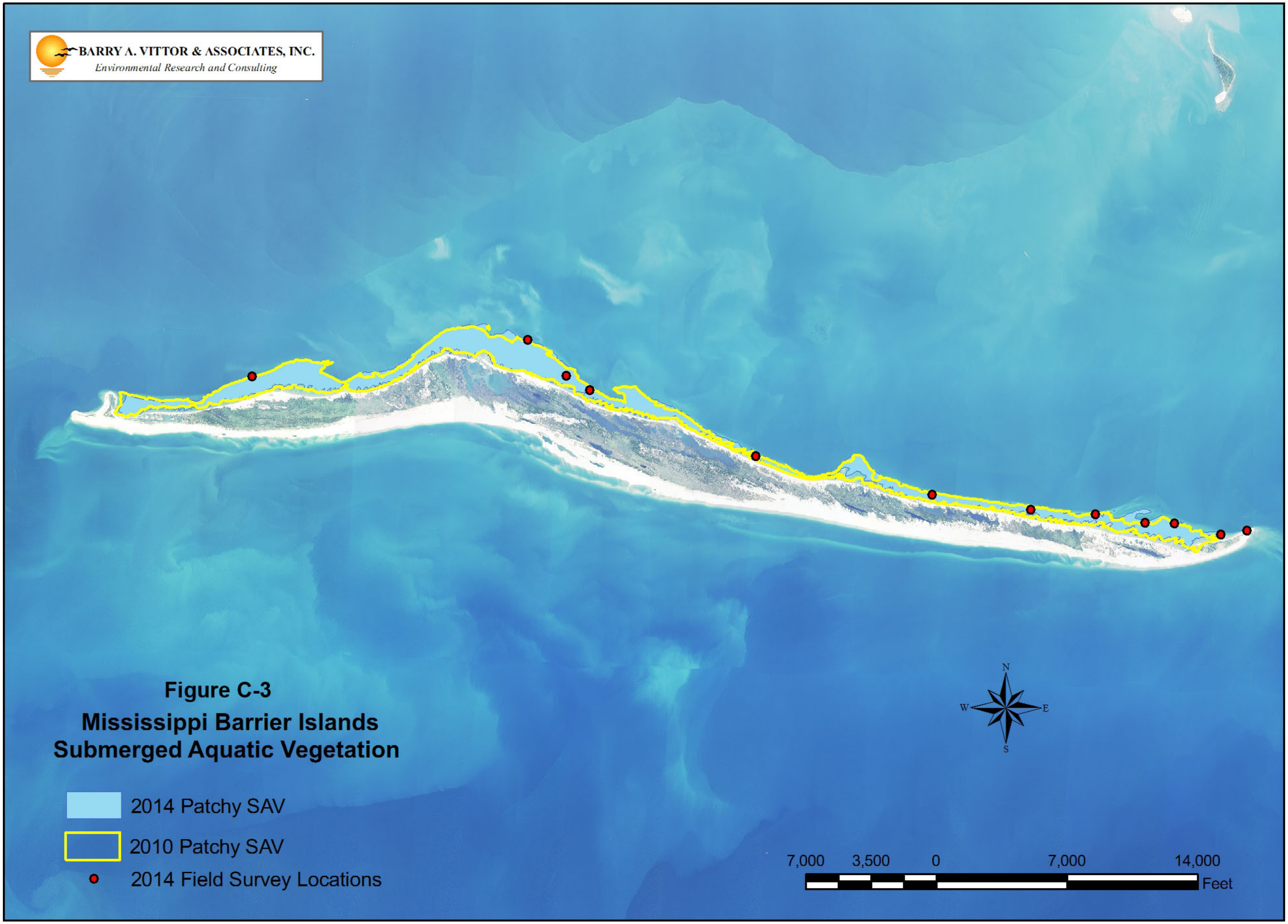
Figure B-5
Petit Bois Island

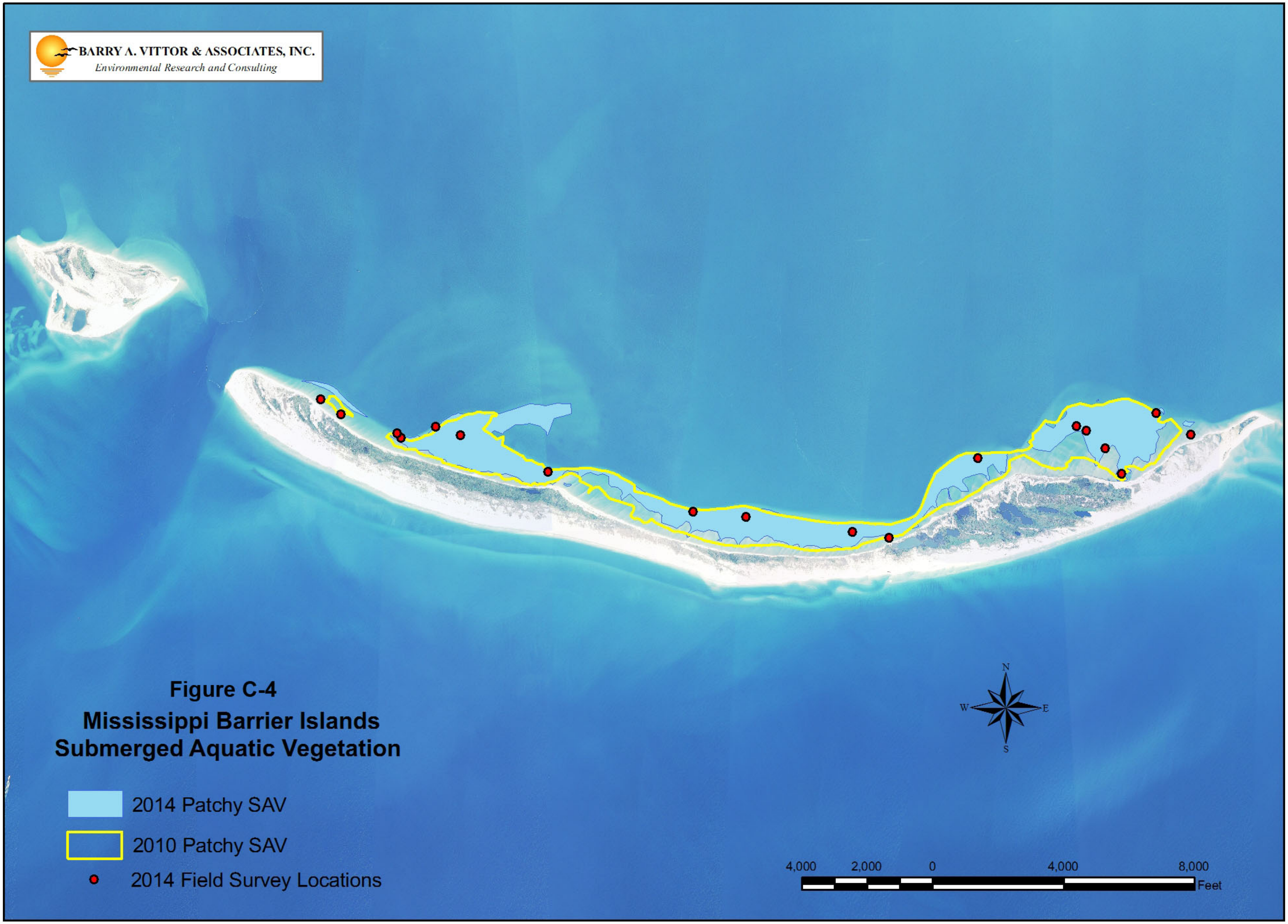
Mississippi Barrier Islands
Submerged Aquatic Vegetation
2014

APPENDIX C – 2014 COMPARISON WITH 2010 MAPS


BARRY A. VITTOR & ASSOCIATES, INC.
Environmental Research and Consulting
N
W
E
S
Figure C-1
Mississippi Barrier Islands
Submerged Aquatic Vegetation
2014 Continiuous SAV
2014 Patchy SAV
2010 Patchy SAV
2010 Continiuous SAV
2014 Field Survey Locations
4,000
2,000
0
4,000
8,000
Feet


BARRY A. VITTOR & ASSOCIATES, INC.
Environmental Research and Consulting
Figure C-2
Mississippi Barrier Islands
Submerged Aquatic Vegetation
2014 Algae
2014 Patchy SAV
2010 Patchy SAV
2014 Field Survey Locations
N
W
E
S
4,000
2,000
0
4,000
8,000
Feet


BARRY A. VITTOR & ASSOCIATES, INC.
Environmental Research and Consulting
Figure C-3
Mississippi Barrier Islands
Submerged Aquatic Vegetation
2014 Patchy SAV
2010 Patchy SAV
2014 Field Survey Locations
N
W
E
S
7,000
3,500
0
7,000
14,000
Feet


BARRY A. VITTOR & ASSOCIATES, INC.
Environmental Research and Consulting
Figure C-4
Mississippi Barrier Islands
Submerged Aquatic Vegetation
2014 Patchy SAV
2010 Patchy SAV
2014 Field Survey Locations
N
W
E
S
4,000
2,000
0
4,000
8,000
Feet

MAPPING OF SUBMERGED AQUATIC VEGETATION IN 2010

MISSISSIPPI BARRIER ISLAND RESTORATION PROJECT

Prepared for

Mobile District Corps of Engineers
P.O. Box 2288
Mobile, AL 36628-0001

Prepared by

Barry A. Vittor & Associates, Inc.
8060 Cottage Hill Road
Mobile, Alabama 36695

January 2011

EXECUTIVE SUMMARY

This is the technical report for the 2010 mapping of submerged aquatic vegetation (SAV) in Mississippi Sound, as part of the Mississippi Barrier Island Restoration project. The geographic focus of this project was the barrier island system off the mainland of coastal Mississippi. This report documents the digital mapping effort that provides detailed information on the distributions of SAV in the barrier island study area during 2010.

For this SAV mapping project a digital database was developed using aerial imagery and complementary surface-level verification. Digital orthophotographs were created from native aerial imagery acquired with a digital mapping camera. Aerial imagery was obtained July 22, 2010. An Airborne Global Positioning System (ABGPS) and inertial measurement unit (IMU) were used to accurately position each aerial photo center (principal point). Processed ABGPS/IMU data were used in an aerotriangulation procedure to produce a digital elevation model (DEM) surface for imagery rectification. Outlines of SAV signatures in the ortho imagery were digitized in a GIS environment. Digitized areas were field-verified to document habitat characteristics at the surface level.

As in previous surveys of the study area, SAV was mostly concentrated on the north side of the barrier islands. SAV was shoal grass (*Halodule wrightii*) at all locations. Overall, a total of 3,614 acres mapped. Bed densities were mostly patchy (< 50% coverage). SAV acreage by barrier island area was as follows:

Location	Density	Acreage
Cat Island	Continuous	178
Cat Island	Patchy	1,534
E Ship Island	Patchy	261
W Ship Island	Patchy	125
Horn Island	Patchy	974
Petit Bois Island	Patchy	541

TABLE OF CONTENTS

LIST OF FIGURES

APPENDIX A – SAV DISTRIBUTION MAPS

1.0 INTRODUCTION

This is the technical report for the 2010 mapping of submerged aquatic vegetation (SAV) in Mississippi Sound, as part of the Mississippi Barrier Island Restoration project. The geographic focus of this project was the barrier island system off the mainland of coastal Mississippi (Figure 1-1).

Figure 1. Study area for the 2010 survey of SAV near the Mississippi Barrier Islands.

For this SAV mapping project a digital database was developed using aerial imagery and complementary surface-level verification. In 1995 the U.S. Department of Commerce published benthic habitat mapping methods in a document entitled *NOAA Coastal Change Analysis Program* (C-CAP) (Dobson et al., 1995). The C-CAP is a nationally standardized database of land cover and land change information in coastal areas, developed using remotely sensed imagery. The C-CAP outlines methods and provides technical guidance for digital feature mapping. This project was conducted within the technical framework established by the C-CAP.

2.0 METHODS

2.1 ORTHOPHOTOGRAPHY PRODUCTION

Photo Science of St Petersburg, FL acquired the aerial imagery and produced the ortho imagery for this mapping project. The orthorectification process relied on digital aerial imagery, ground control/aerotriangulation data, and a digital elevation model (DEM).

The aerial mapping technology used was airborne Global Positioning System (ABGPS) and an inertial measurement unit (IMU) to accurately position each aerial photo center (principal point). The processed GPS/ABGPS/IMU data were used in an aerotriangulation procedure to produce a digital elevation model (DEM) surface for imagery rectification. The DEM removed imagery displacements inherent in the aerial photography, such as distortions resulting from camera tilt and ground relief, to create digital orthophotographs with uniform scale and a high degree of accuracy.

<u>Digital Aerial Imagery</u>

Aerial imagery was acquired July 22, 2010, using a Z/I Imaging Digital Mapping Camera (DMC). The DMC was equipped with eight (8) cameras heads, four (4) for panchromatic and one (1) each for red, blue, green and NIR (near-infrared).

A computerized flight-management system was utilized during imagery acquisition. GPS-supported aircraft navigation interfaced with the DMC control software. After initial flight planning, digitized mission data were fed into the flight-management system. The start and stop points of each flight line were processed by the aircraft's onboard navigation system.

Dual-frequency GPS observation data were collected on-board the aircraft at a one second epoch. Additionally, inertial data was collected at a rate of 0.005 seconds during all periods of flight. The midpoint of each photo exposure was precisely captured by the GPS receiver. All ABGPS and Inertial data was then post-processed using Applanix MMS version 5.2 software to provide accurate positional and rotation data of the camera for each exposure. Effectively, the three dimensional position (x, y, and z) of each exposure was determined from the ABGPS data while the three-dimensional rotation (omega, phi, and kappa) of each exposure was determined from the inertial data.

An Applanix (Ontario, Canada) POS/AV-DG IMU system was used during all photo collection to measure the position of the camera perspective center and orientation angles of each photograph at the midpoint of exposure, to an accuracy of 5-10 cm and 20-30 arc seconds, respectively. During imagery acquisition the aircraft flew at 27,000 feet AMT to render a native pixel resolution of 1 meter for the entire study area. The Applanix Inertial Measurement Unit (IMU) ensured that tip, tilt, and swing of the camera for each frame was less than 3 degrees. Resolution loss due to blurring was avoided by a forward image motion compensation (FMC) system. Image motion did not exceed 0.002 inches. Each individual frame was formatted for 60% endlap and 30% sidelap.

Positional Accuracy

Airborne Global Positioning System (ABGPS) coordinates were automatically collected for the principal point for each photographic frame during imagery acquisition. The ABGPS/IMU recorded the position and orientation of the camera platform during all flight missions. Exact measurements obtained from the ABGPS and IMU provided positional accuracy of the resultant imagery suitable to support generation of ortho imagery.

Orthorectification

A 30-m DEM provided by the USGS was used for the orthorectification process. Cubic convolution re-sampling was used during the rectification process. The rectification methodology sharpened the edges of linear features and sampled 16 of the closest pixels and performed a weighted adjustment.

Orthophotos were produced as individual rectified image frames. Color balancing was performed on the digital images to provide a consistent tone, brightness and contrast throughout the project area. Digital orthophotos are projected to North American Datum of 1983, Universal Transverse Mercator (UTM) Zone Number 16 North, and meters. A low-resolution mosaic was created in a MrSID format.

2.2 SAV DATA DEVELOPMENT

Creation of Polygonal and GIS Database

The ortho imagery was observed in ArcView GIS, and SAV boundaries were digitally delineated on a computer screen display. ESRI polygon coverage was created in ArcView version 9.3. Once the preliminary line work was completed, polygon vector coverage was created using building, editing, cleaning, and labeling the polygonal line work. Overlapping photographs were used for verification and comparison when delineating areas of interest. The minimum mapping unit (MMU) for this project was 0.03 hectares (0.1 acres). Polygons were visually assessed for vegetation density on a screen display and categorized as continuous (>50%) or patchy (<50%) coverage. SAV signatures were distinguishable in the photography for most of the study area (Figure 2).

Field Surveys

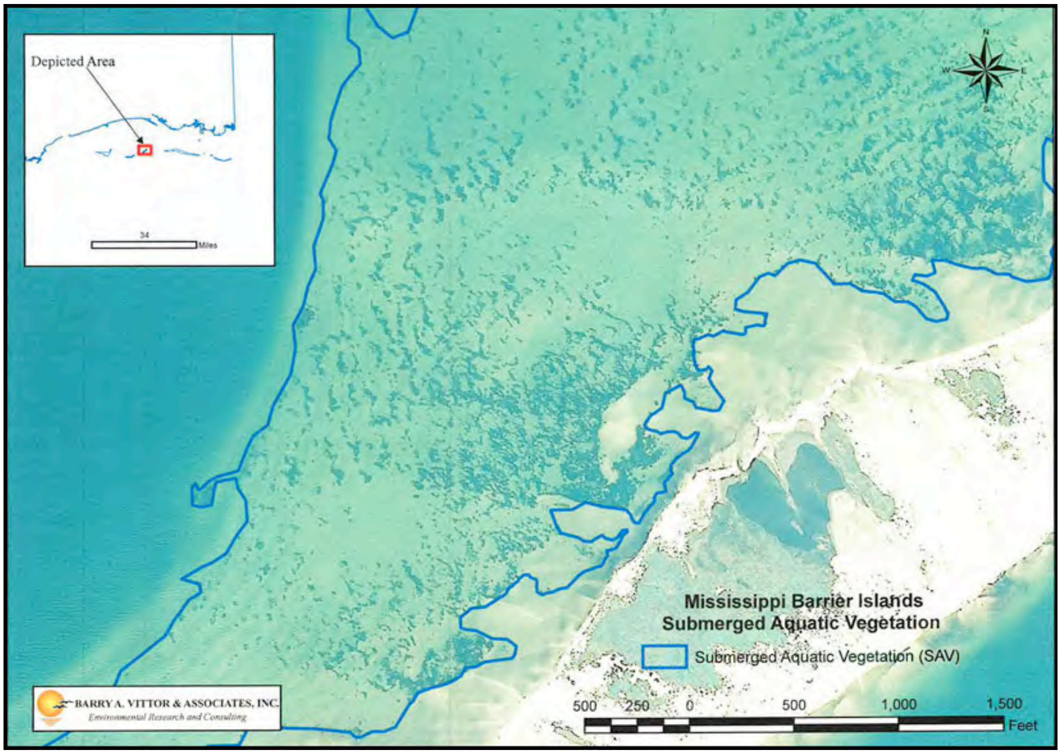
Field surveys were conducted to document SAV presence and habitat characteristics. Ambiguous signatures in the imagery included submerged objects and bathymetric depressions. Questionable areas were visited in the field to verify assumptions regarding identification of photographic signatures. Locations of interest identified through review of the aerial imagery were pre-plotted in GPS to aid navigation. Field verification surveys were conducted on the following dates:

West Ship Island - August 2, 2010
Cat Island and East Ship Island - September 28, 2010
Horn Island and Petit Bois Island - October 8, 2010

Field locations were logged using a Trimble Pro XR differential GPS unit, and followed common GPS practices. An elevation mask of 6 was used to avoid degraded signals from satellites. A Positional Dilution of Precision (PDOP) threshold of 6, data logging at 2-second intervals, and real-time differential correction/post-processing of the field data collected positional data accurate to within 1 meter. Data were collected at a total of 40 field points.

QA/QC

Two analysts identified potential SAV signatures using a screen display. Analysts visually reviewed the polygons superimposed on the digital imagery to check completeness and edges. Analysts consulted regarding questionable areas, and the entire polygonal data set was reviewed after completion.



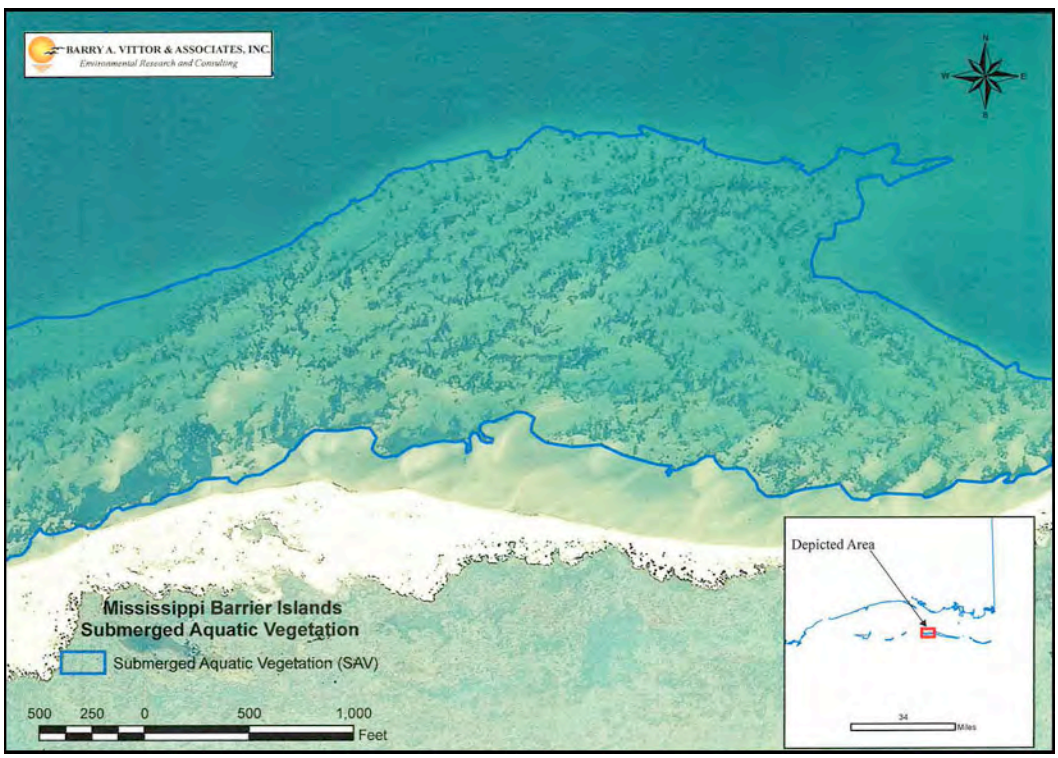


Figure 2. 2010 aerial imagery showing shoal grass on the northern side of East Ship Island (top) and Horn Island (bottom).

3.0 RESULTS

SAV was mostly concentrated on the north side of the barrier islands (Figures A-1; Appendix A). Figures A-2 through A-5 show the detailed distribution of shoal grass at each island. SAV acreage for each barrier island area was as follows:

Location	Density	Acreage
Cat Island	Continuous	178
Cat Island	Patchy	1,534
E Ship Island	Patchy	261
W Ship Island	Patchy	125
Horn Island	Patchy	974
Petit Bois Island	Patchy	541

Overall, a total of 3,614 acres mapped. SAV was shoal grass (*Halodule wrightii*) at all locations. Bed densities were mostly patchy (< 50% coverage), as shown in Figure 2-1. Cat Island had an area of continuous SAV (> 50% coverage) comprising 178 acres (Figure A-2; Appendix A). Previous studies have documented similar distributions near the Mississippi barrier islands (Eleuterius, 1973; Moncreiff et al., 1998), indicating some temporal stability of SAV occurrence on a decadal scale.

4.0 REFERENCES CITED

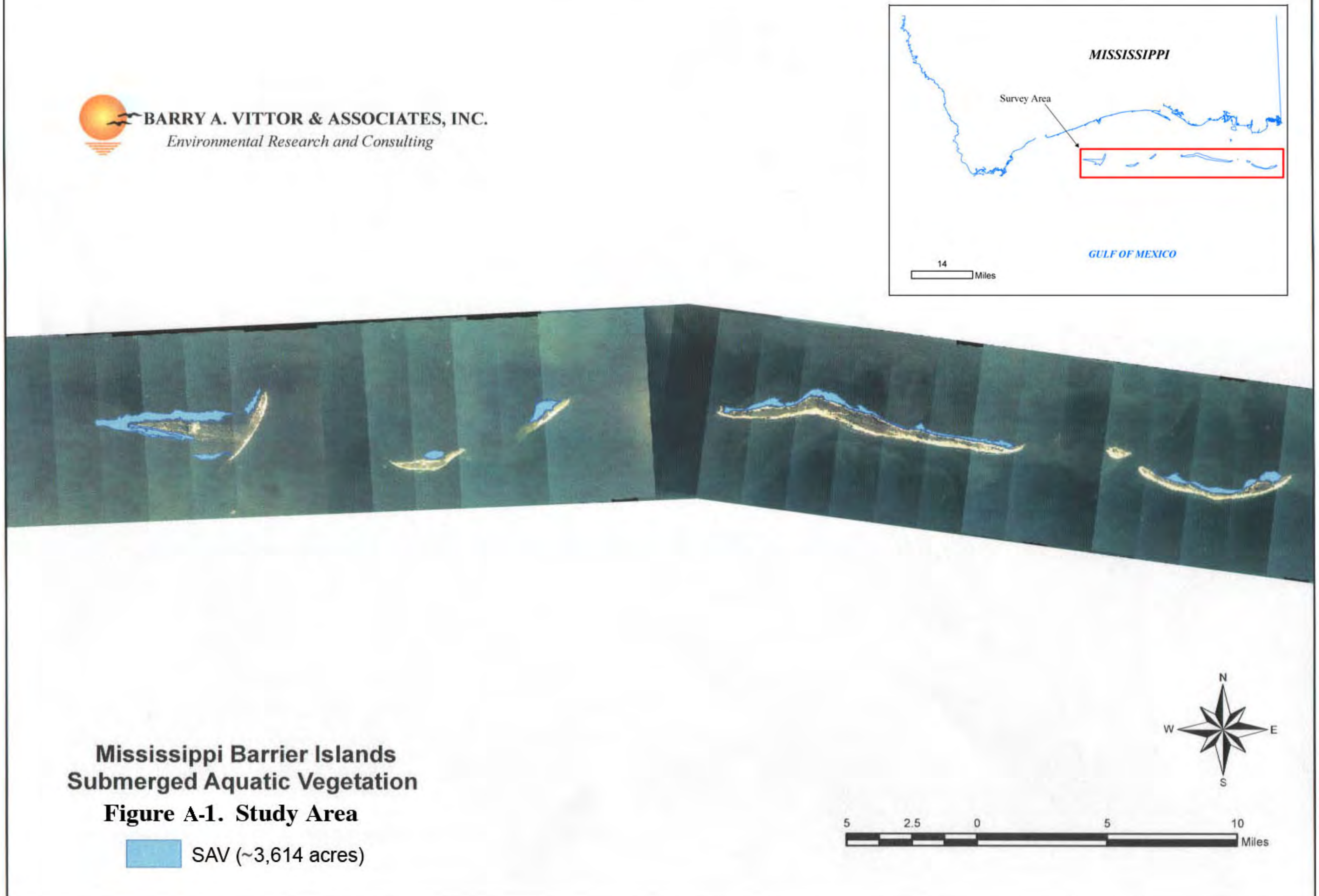
Dobson, J.E., E.A. Bright, R.L. Ferguson, D.W. Field, L.L. Wood, K.D. Haddad, J.R. Jensen, H. Iredale, V.V. Klemas, R.J. Orth, and J.P. Thomas, 1995. NOAA Coastal Change Analysis Program (C-CAP): Guidance for Regional Implementation. NOAA Technical Report NMFS 123. U.S Department of Commerce.

Eleuterius, L.N., 1973. Phase II: The distribution of certain submerged plants in Mississippi Sound and adjacent waters. Pp. 191-197, In J.Y. Christmas (ed.), Cooperative Gulf of Mexico Inventory and Study, Mississippi. Gulf Coast Research Laboratory, Ocean Springs, MS.

Moncreiff, C.A., T.A. Randall, and J.D. Caldwell, 1998. Mapping of Seagrass Resources in Mississippi Sound. Gulf Coast Research Laboratory, University of Southern Mississippi, Ocean Springs, MS. 41 pp.

APPENDIX A – SAV DISTRIBUTION MAPS

BARRY A. VITTOR & ASSOCIATES, INC.
Environmental Research and Consulting



Mississippi Barrier Islands
Submerged Aquatic Vegetation

Figure A-1. Study Area

SAV (~3,614 acres)

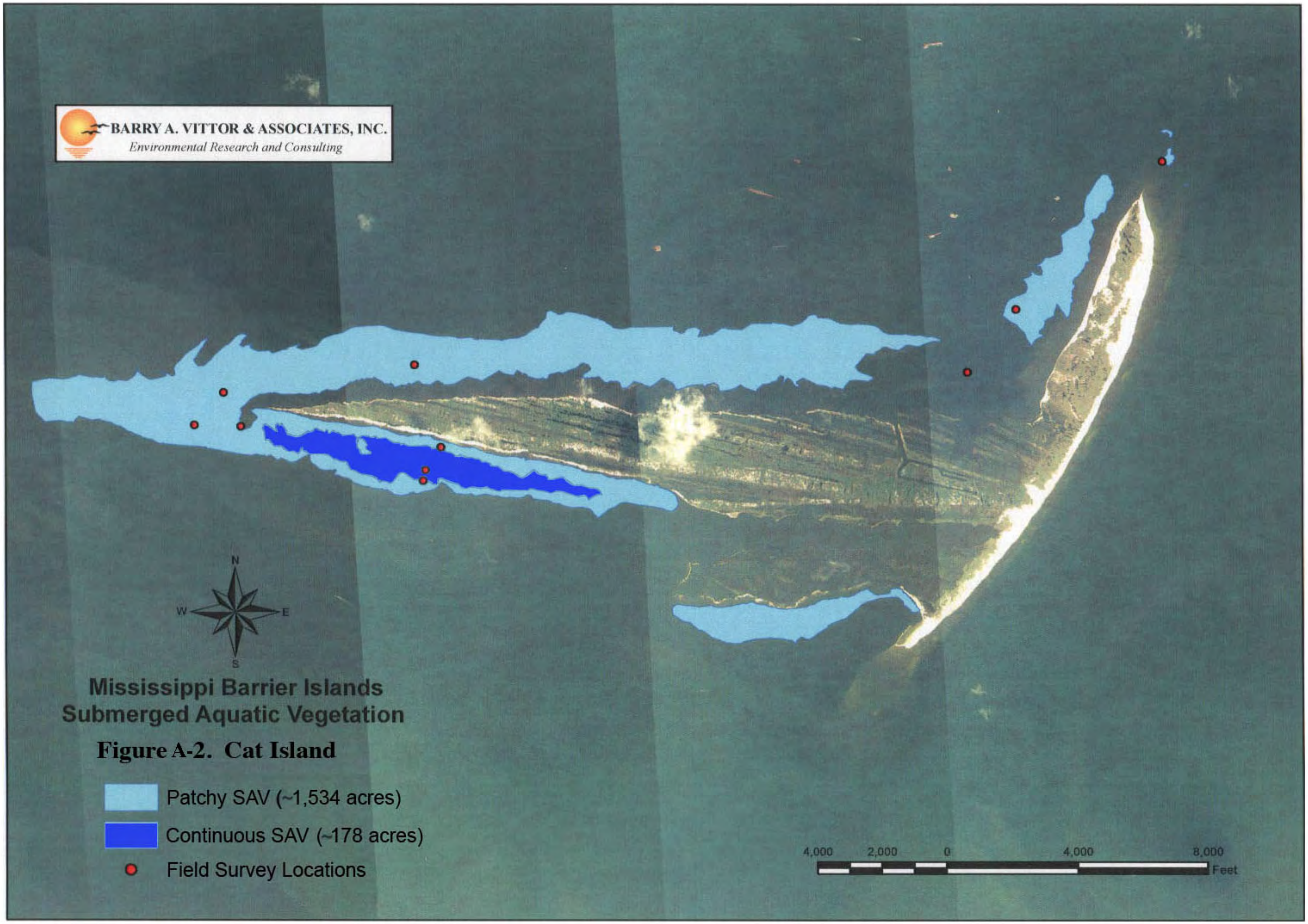


Figure A-2. Cat Island

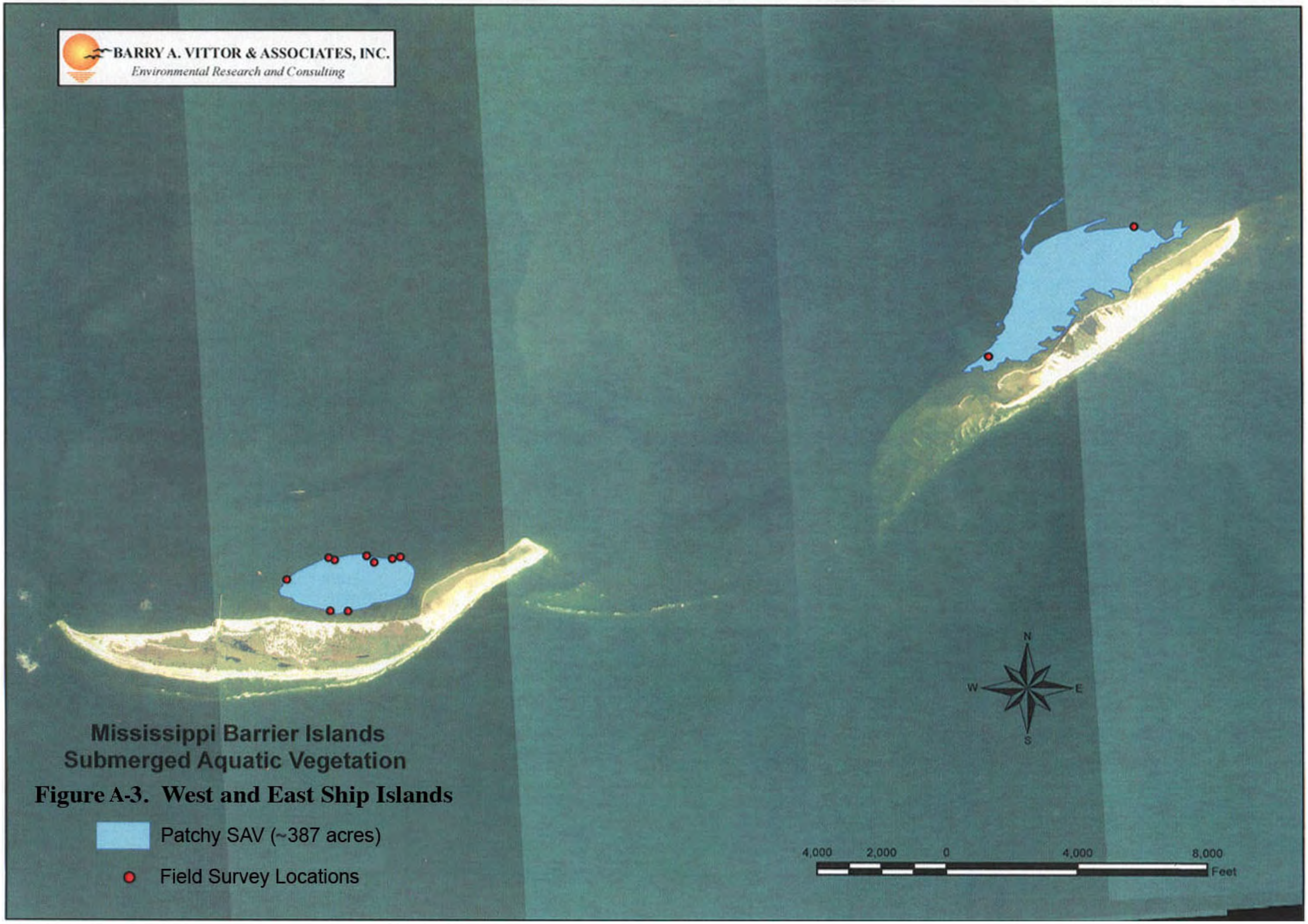


Figure A-3. West and East Ship Islands

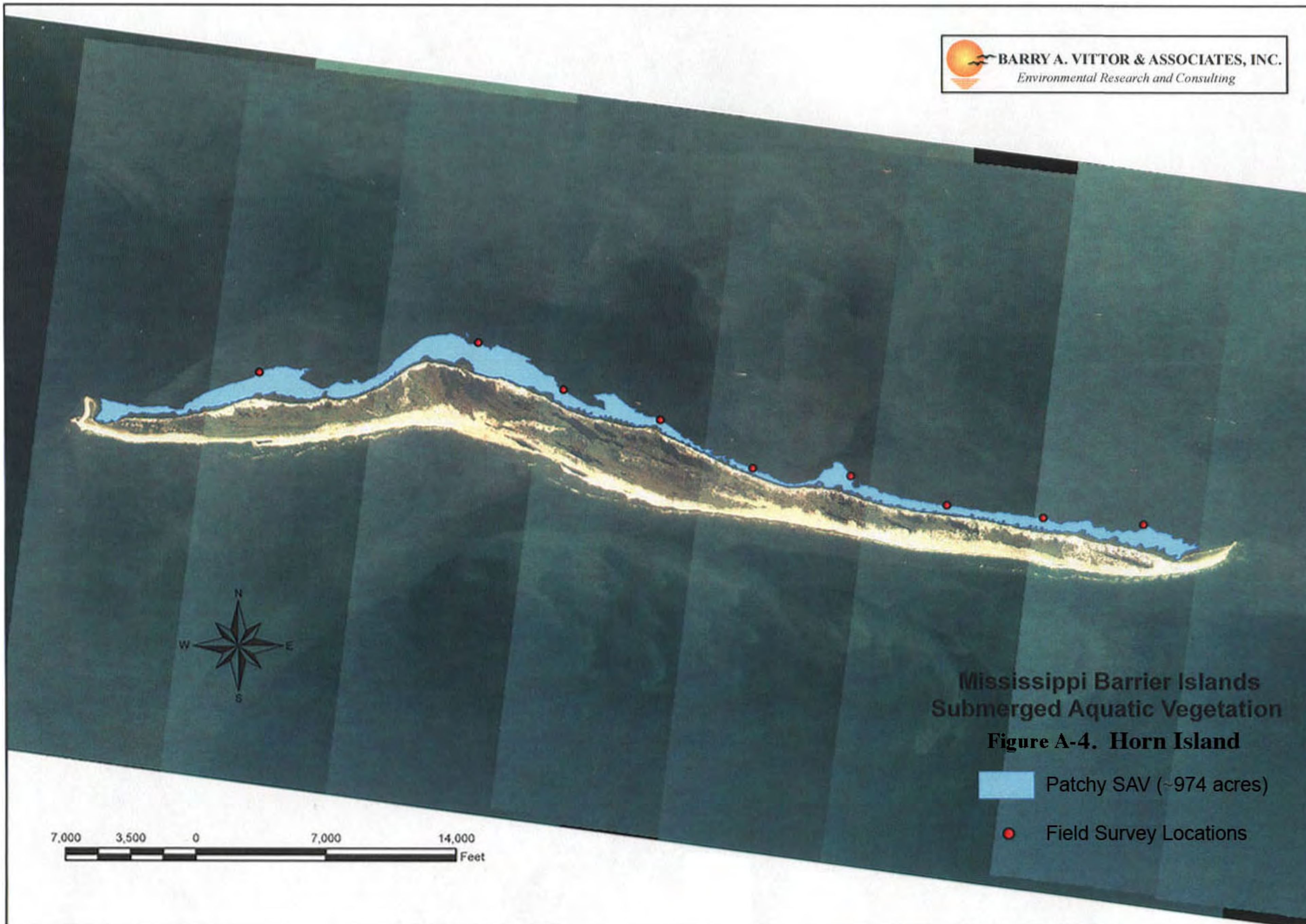


Figure A-4. Horn Island


BARRY A. VITTOR & ASSOCIATES, INC.
Environmental Research and Consulting
Mississippi Barrier Islands
Submerged Aquatic Vegetation
Figure A-5. Petit Bois Island
Patchy SAV (~541 acres)
Field Survey Locations
N
W
E
S
4,000
2,000
0
4,000
8,000
Feet